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SYSTEM AND METHOD FOR MATCHING HUMAN  
RESOURCES TO HUMAN RESOURCE NEEDS

BACKGROUND OF THE INVENTION

1. Related Applications.

5       The present invention claims priority to copending  
U.S. Provisional Patent application serial No. 60/180,421  
entitled ELECTRONIC RESOURCE MANAGEMENT SYSTEM filed  
February 4, 2000 the specification of which is  
incorporated herein by reference.

10      2. Field of the Invention.

The present invention relates, in general, to  
resource management, and, more particularly, to software,  
systems and methods for matching human resources to human  
resource needs of an organization.

15      3. Relevant Background.

20       The world economy is characterized by a scarcity of  
skilled human resources for a variety of jobs. As the  
educational and experience requirements increase in a  
technological society, the pool of people having necessary  
and desired skills becomes smaller. This creates a  
situation in which many jobs are chasing fewer and fewer  
skilled workers. This is complicated in many industries,  
employees tend to move from job to job every few years.  
This is particularly true of skilled employees and even  
25   more particularly true in the information technologies  
industries. An advantage in identifying, obtaining and

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managing employees represents a significant strategic advantage for an organization.

It is increasingly difficult for employers to identify and hire qualified employees and contractors for particular positions. Human resource needs often arise suddenly and unpredictably, but must be filled quickly. With product development cycles and product life cycles becoming shorter, personnel with needed skills must be identified and hired quickly. At the same time, each candidate and position must be sufficiently analyzed to make meaningful decisions.

Job matching systems tend to be modeled after bulletin boards where available positions and/or applicants are posted and the other party must periodically peruse or search through the postings. This is inefficient because the participants are only made aware of other participants at the instant they conduct a search or log on. A new job applicant that registers moments after a search was performed will not be reported to the searching party, for example. Hence, participants must access the system frequently and conduct searches to obtain up to date information.

Search-based systems have limited ability to deal with the various words, terms and syntax used in the postings. A given job posting, for example, is amenable to a variety of expressions and it is difficult, even with natural language search engines, to effectively search through the various listings and leave with certainty that the most relevant matches have been found by the search engine. Many words and terms in the English language, when viewed in context, imply much more than the word's literal definition. Strict text-based matching used by

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search engines miss these implications. Even fuzzy matching, which is often based upon a words syntax, synonyms, antonyms and the like, tend to miss complex meanings that are implied by simple words and the context in which they are used. For example, a job applicant may express that they have Java programming experience, which a typical search tool will match with job descriptions that call for Java experience. However, such experience implies that the applicant has object-oriented programming knowledge which would not be identified by conventional search engines and fuzzy matching techniques. A need exists for a system and method that overcomes the limitations of search-based systems to detect, imply, and deduce matches in a context-sensitive manner.

Another limitation of conventional systems is that even where an applicant's abilities and skills are accurately expressed, there is no way for the applicant to express a desire to use those skills in future employment. To retain workers it is desirable to find workers that are interested in the job and interested in the skills required by the job. For example, a person may be a skilled Cobol programmer, but uninterested in taking a position that uses those skills. Conventional worker identification systems do not consider worker interests and desires and so risk creating job matches that will be difficult to manage and maintain over time.

In-person job matching through conventional interviews and negotiation is inefficient, time consuming, and expensive. Also, it tends to be biased as the participants may express different needs and desires in an attempt to satisfy perceived requirements of the other party. This bias can result in sub-optimal matching of human resources to human resource needs.

A need also exists for systems and software that provide services beyond the identification and matching of potential candidates to job openings. Once a match is defined the life cycle of a typical hiring process continues through negotiations, travel, interviews, testing, and contracting among other steps. These steps are typically managed manually using lists or personal information management products. Hence, a need exists for providing follow on services to manage the hiring process in an integrated fashion.

## SUMMARY OF THE INVENTION

Briefly stated, the present invention involves a system for matching entities having needs to entities having capability to meet the needs. A plurality of needs  
15 profiles are created, where each need profile comprises a data record specifying attributes about a need. A plurality of capability profiles are also created, where each capability profile comprises a data record specifying set of attributes of an entity having a capability of  
20 meeting a need. A matching engine is coupled to repetitively and automatically examine the needs profiles and capability profiles to identify matched profiles, wherein a match comprises a set of profiles judged to be substantially compatible based upon correspondence of the  
25 attributes specified therein.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an networked computer environment in which the present invention is implemented;

Fig. 2 shows an electronic commerce environment in  
30 which the present invention is implemented;







architecture in accordance with the present invention to implement the processes of Fig. 2. Essentially, the present invention provides an integrated solution for identifying workers having skills that meet job specifications in identification process 201. Identification process 201 also involves identification of jobs that have specifications meeting the desires and preferences of particular skilled workers. Process 210 includes matching engine processes 311 (shown in Fig. 3) for enable a hiring manager to quickly identify a "short list" of qualified and available candidates for an available position. Process 201 provides functionality for hiring managers to efficiently post, edit and delete job descriptions. Once a match is created match manager processes 312 automate the life cycle of the procurement process 202. It allows participants to automate the workflow of finding a qualified candidate as well as placing and managing that candidate in their organization.

Hiring managers may optionally submit job descriptions to a selected supplier list in process 201. Methods are included to enable hiring managers to manage interactions between the suppliers of the qualified applicants. Process 201 also provides equivalent functionality for the suppliers of candidates in posting, editing and deleting profiles or portfolios that are used to match against the job specifications. In a particular implementation, suppliers of resources automatically or manually match their candidates to jobs that they are made aware of via the Internet or by explicit notification.

While many features of the present invention involve identification process 201, it is important to understand that these processes affect downstream processes such as procurement processes 202 and management processes 203.



Procurement processes 202 includes interview scheduling processes 322 and employs messaging processes 334 to enable an employer and a candidate to move beyond the generation of a match and discuss specifics of a job opportunity. Exemplary functions include exchanging protected information between the parties (including sending company information and contact information to the participants), reviewing a detailed profile of the candidate, scheduling interviews with the candidate, and capturing interviewer feedback on a candidate in an on-line repository.

Processes 202 optionally include skills validation process 321 including pre-employment screening processes to provide independent verification of skills that are listed on the candidate profile. It is contemplated that these optional functions may include scheduling on-line testing of available skills tests with the candidate, scheduling independent verification of specific skill categories with candidate, entering and/or reviewing test or verification results on-line, and interfacing with other repositories of skills certifications. Processes 202 may also provide a means to manage candidate background checks, reference checks, drug testing, and the like using, for example, auxiliary services 111.

Procurement process 202 provides interface(s) through which participants may perform contract management functions. Procurement process 202 optionally includes automated contract management components 323 (shown in Fig. 3) that are used when the employer and job seeker are ready to enter into a contract for services. Employers and job seekers may enter a new contract/consulting agreement or copy one from an existing template or archive. The participants may extend and/or approve

contract offers on-line in a preferred implementation. In other implementations, participants may receive automatic notification of contract termination, perform contract reporting to compare budget to actual dollars, percentage completion analysis and the like. Directly or through auxiliary services, procurement processes 202 optionally perform compliance reporting (EEOC, MBE/MWBE).

The procurement processes are typically provided to contract participants which may be supplier agents and hiring agents working on behalf of employees and employers, respectively. It is contemplated that procurement processes 202 may be provided directly to employees and/or employers even though the identification processes were provided indirectly through their respective agents. These modification and alterations are equivalent to the processes described herein.

Optional management processes 203 implement various interfaces and processes that enable participants to manage an employment contract after it is formed. Management processes are particularly desirable in contract employment situations where the employment contract specifies certain activities, billing arrangements, payment arrangements, and progress criteria. A time and expense management component 331 provides interfaces to the processes associated with consultant timesheets and expense reports a particular example. Component 331 includes entering and submitting timesheets and expense reports associated with specific work orders, reviewing and approving consultant timesheets and expense reports, including partial approval capability and support for multi-level approval chains, and reporting time and expense by work order, consultant, supplier firm, and the



This implementation also permits integration with third party applications by wrapping logic using enterprise Java Bean technology. Moreover, the architecture shown in Fig. 3 enables a robust enterprise environment that provides a  
 5 scalable, consistent architecture with 7x24 availability on the World Wide Web (WWW).

The J2EE standard provides a model for developing distributed applications that are multi-tiered and use a thin-client strategy. Such application are desirable for  
 10 delivery via the Internet to conventional web browser software. This implementation reduces demands on client-side systems and enables a wide variety of appliances 117 (shown in Fig. 1) to access the human resources services 108.

The application is partitioned both across tiers and across functional groups. Partitioning across tiers allows distributed deployment, robustness under load stress and hardware failures, and integration of disparate component technologies and legacy applications into an  
 20 integrated whole. Partitioning across functional groups permits easy expansion of application functions, modification of existing functions, as well as separate, specialized deployment of different functional groups based on user demand or hardware optimizations.

Common application components 330 are leveraged across all of processes 201, 202 and 203. Personalization component 333 enables the look-and-feel provided to participants to be customized to match the appearance of client and/or vendor web-sites, allowing functionality to  
 30 be seamlessly integrated into customer intranets and web sites. The sequence of operations performed during the hiring process may also be tailored to a particular

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server 108. Administrative access to systems is controlled via available remote access software.

Fig. 4 illustrates exemplary entities and data transactions in an implementation of the present invention. Human resources server 108 enables transactions between hiring agents 401 and human resource suppliers 402. Hiring agents represent staffing agencies, human resource departments and personnel, and similar entities that are tasked with supplying human resources to meet the needs of one or more jobs. A hiring agent 401 may be an employer or an entity contracted to find skilled workers on behalf of an employer. Human resource suppliers 402 represent staffing agencies, job shops, headhunters and similar entities that represent one or more candidates or job applicants. It is contemplated that job applicants may access the system directly as well.

Hiring agents 401 generate one or more profiles 404 that include attributes of job descriptions including information such as employer name, job title, salary, and other contract terms. Profile 404 will include some data that is public in that it can be shared with other participants with access to human resource server 108. Profile 404 also includes restricted and private data that can be used by human resource server 108 but is either not shared with other participants or is shared with other participants according to rules specified by the associated hiring agent 401. In this manner, profile 404 becomes an autonomous agent on behalf of the particular job represented by the profile 404 as it embodies self-contained rules enabling the use of data contained therein.

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Supplier agents 402 also generate one or more profiles 406 that include attributes of particular job applicants including information such as name, location, experience, educational background, salary needs, and the like. Like profile 404, profile 406 will also include some data that is public as well as restricted and private data that can be used by human resource server 108 but is either not shared with other participants or is shared with other participants according to rules specified by the associated supplier agent 402. In this manner, profile 406 becomes an autonomous agent on behalf of the particular job candidate represented by the profile 406 as it embodies self-contained rules enabling the use of data contained therein.

Human resources server 108 uses messaging component 334 (shown in Fig. 3) to receive and store received profiles 404 and 406 in data structures 414 and 416, respectively, in a manner that is continuously accessible. Human resource server 108 uses match engine 311 to autonomously monitor data structures 414 and 416. In contrast with search engine based solutions, match engine 311 is self-invoked or is invoked automatically upon the addition of profiles 404 and/or 406 to identify matches between profiles 404 and 406.

Match engine 311 compares each job profile 404 against each job applicant profile 406 and generates one or more scores indicated a degree of compatibility between the profiles. Match engine 311 generates a match record for each profile match. The match record includes identification information associated with the matching profiles 404 and 408 as well as match scores. Each match record has two different scores, how well the candidate meets the job requirements (this score is available to

both the hiring agent and the supplier agent and determines whether or not a match record is created (i.e. over the threshold). The other score is how the job meets the candidate's requirements. In the preferred implementation this second score is only shown to the supplier agent).

Match engine 311 generates a match list 407 of candidates having profiles 406 that are substantially compatible (i.e., have match scores greater than a predetermined threshold) with a particular profile 404. The match list 407 includes the one or more scores for use by hiring agent 401 in assessing and comparing various candidates represented in the list. Match list 407 is communicated using messaging component 334 to the hiring agent 401 corresponding to the profile(s) 404 that are involved in the match.

Match engine 311 also generates one or more scores indicated a degree of compatibility of profiles 404 with a particular profile 406. These scores reflect how well a particular job matches the requirements specified by a job applicant. Although the scores delivered to hiring agent 401 and the scores delivered to supplier agent 402 arise from the same set of data, they may differ in value when the scoring algorithms take into account the differences in perspective between a hiring agent and a job applicant. In a particular implementation the

Match list 408 comprises job descriptions and match records having profiles 404 that are substantially compatible (i.e., have match scores greater than a predetermined threshold) with a particular profile 406. The match list 408 includes the one or more scores for use



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by supplier agent 402 in assessing and comparing various  
job descriptions represented in the list. Match list 408  
is communicated using messaging component 334 to the  
supplier agent 402 corresponding to the profile(s) 406  
5 that are involved in the match.

In the particular implementation, messaging component  
334 is the primary interface for users when first  
connecting to human resources server 108. Through this  
interface a user is immediately informed of objects in the  
10 system upon which the user may take action. The messaging  
component 334 provides email message capability to send  
notification of events within the business workflow to  
provide real time hiring process management. These  
notifications are configurable for each user and can be  
15 related to or triggered by events, (e.g. a match is  
accepted by hiring agent 401) or to non-events (e.g. a  
hiring manager 401 accepted a match on a suppliers  
candidate but two days have elapsed since acceptance).

Messaging component 334 may also be used for more  
20 sophisticated delivery of discrete units of functionality  
to appliances 117 such as hand-held smart devices, such as  
a personal digital assistants, smart cards and or smart  
phones. These discrete units of functionality (analogous  
to browser applets) may be executed on the hand-held  
25 device to interact with the systems of the present  
invention and perform operations such as accepting a  
match, submitting a time sheet, or approving an expense  
report.

Once one or more matches are identified, match  
30 manager component 312 handles workflow tasks such as  
generating match list 407 as well as further tasks shown  
in Fig. 5 and Fig. 6. A hiring agent 401 may review a

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match list and accept or express interest in one or more matches by generating a message 501 to server 108. Depending on the business rules in effect, match manager 312 may notify supplier agent 402 upon receipt of message 501, or take alternative action such as providing detailed information message 502. Message 502 includes, for example, information that may have been designated as restricted by the job applicant or supplier agent 402 and released only upon an expression of specific interest by a hiring agent 401. The exchange of messages 501 and 502 may continue iteratively as hiring agent 401 gathers additional information about a particular identified match.

On the supplier agent side, a match list 408 is reviewed and supplier agent 402 may also accept or express interest in one or more matches by generating a message 511 to server 108. Depending on the business rules in effect, match manager 312 may notify hiring agent 401 upon receipt of message 502, or take alternative action such as providing detailed information message 512. Message 512 includes, for example, information that may have been designated as restricted by the hiring agent 401 or employer and released only upon an expression of specific interest by an supplier agent 402. The exchange of messages 511 and 512 may continue iteratively as supplier agent 402 gathers additional information about a particular identified match.

Fig. 6 illustrates data exchanges associated with an actual employment or consulting contract being formed. Although Fig. 6 suggests the contract is between hiring agent 401 and supplier agent 402, it should be understood that it is intended that a contract is formed between a candidate employee or contractor and a corresponding





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applicant, for example and may include checking on-line  
post-performance information maintained by human resource  
server 108 itself. Skill validation involves is  
certifying any abilities for which hiring agent 401 has  
5 requested certification.

Upon satisfactory completion of courting state sub  
processes, the match transitions to an interview state  
where in person, telephone, video conference or other  
interview processes are executed. Typically a job  
10 applicant is interviewed by one or more representatives of  
hiring agent 401 or the actual employer represented by  
hiring agent 401.

The interview state is typically exited by  
communication of an offer to a job applicant at which time  
15 the offer pending state is entered. The offer pending  
state may persist for a variable length of time while an  
offer is considered and counteroffers and negotiations  
take place. Upon reaching an agreement, an acceptance is  
communicated resulting in a transition to a contracted or  
20 closed state.

Fig. 8 illustrates functional components, typically  
implemented as software, within an exemplary matching  
engine 311. In a particular implementation, three  
separate matching processes are performed to generate  
25 three distinct scores for each match. In each of the  
matching processes, data from profile databases 414 and  
416 is used to generate scores for both the supplier agent  
402 and the hiring agent 401. The matching processes  
generate a similarity index using the structured format of  
30 profiles 404 and 406 in combination with a hierarchical  
and context-sensitive analysis of words and terms used to  
create profiles 404 and 406. In this manner, the matching

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processes identify a larger set of meaningful matches and may be used in combination with available fuzzy logic matching techniques. Once a similarity index is determined, scores are computed by normalizing and weighting factors to the index.

The final scores are normalized to a convenient scale such as 1-100 that provides a quantitative assessment of the substantiality of the compatibility between two profiles. Skills and education component 801 matches skills requirements as well as educational requirements listed within profiles 404 and 406. Location component 803 generates a matching score on geographic preferences and/or requirements. Compensation component generates a score based on compensation desires and requirements. While it is possible to mathematically combine these three scores into a single index using weighting algorithms, the particular implementation provides the scores separately so that the hiring agent 401 and/or supplier agent 402 have more information upon which to base their decisions and negotiations.

Fig. 9 and Fig. 10 show exemplary user interfaces used to enter job candidate information for use in a profile 406. Similar user interfaces are used to obtain hiring agent or job specification information. Fig. 9 and Fig. 10 shows an interface generated in a web browser window in a Microsoft Windows operating environment, although other operating environments and user interface platforms that can display user input controls, including command line input screens, would be appropriate substitutes in some applications. The interfaces shown in Fig. 9 and Fig. 10 include a plurality of user input controls such as text input boxes, radio buttons, check boxes, pull down boxes and the like. Information and

instruction is conveyed by text fields positioned adjacent the appropriate user input controls although instruction may be conveyed by floating help boxes as well as audio, video and multimedia communication means. In Fig. 9 and  
 5 Fig. 10 the user input controls correspond to attributes in a profile 406 that can be communicated to and persistently stored in human resources server 108.

In Fig. 9 the information that is gathered includes basic identification information such as name, job title,  
 10 social security number, and contact information. Status information indicates weather the associated job applicant is actively seeking another position. Resource type information enables the user to distinguish between contract employees and permanent employees, for example.  
 15 Other information is gather for use in matching with job description profiles 404 such as availability dates and an indication of supplier agent(s) that are managing the particular job applicant.

In addition to the identification and management  
 20 information, job applicant skills, education, roles, and preferences are indicated in various user input controls shown in Fig. 9 and Fig. 10. In Fig. 9, the user scrolls through a constrained list of skill titles and selects the "add skill" button to add the skill to the inventory list  
 25 shown in Fig. 10. Similarly, the user selects from a constrained list of applicable roles and selects the "add role" control to include the role on the inventory list of Fig. 10. Once all applicable skills and roles have been identified, the interface shown in Fig. 10 is presented to  
 30 obtain applicant-specific quantification of the skills and roles selected. An exemplary set of quantification information includes a judgment as to relative level of a particular skill (e.g., selected from "novice", "trained",





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Although the invention has been described and illustrated with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example, and that numerous changes in the combination and arrangement of parts can be resorted to by those skilled in the art without departing from the spirit and scope of the invention, as hereinafter claimed.